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Applicant: Tomoki TODO et al.

Title: USE OF SOLUBLE COSTIMULATORY FACTOR FOR TUMOR IMMUNO-GENE THERAPY

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UTILITY PATENT APPLICATION TRANSMITTAL

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Sir:

Transmitted herewith for filing under 37 C.F.R. § 1.53(b) is the non-provisional utility patent application of:

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Enclosed are:

[X] Specification, Claim(s), and Abstract (12 pages).

[X] Informal drawings (4 sheets, Figures 1-4).

[ ] Declaration and Power of Attorney (___ pages).

The filing fee is calculated below:

	Claims as Filed		Included in Basic Fee		Extra Claims		Rate		Fee Totals
Basic Fee							$710.00		$710.00
Total Claims:	32	-	20	=	12	x	$18.00	=	$216.00
Independents:	4	-	3	=	1	x	$80.00	=	$80.00

If any Multiple Dependent Claim(s) present:		+ $270.00	=	$0.00
		SUBTOTAL:	=	$988.00
[X]	Small Entity Fees Apply (subtract ½ of above):		=	
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[ ] A check in the amount of $_____ to cover the filing fee is enclosed.

[**X**] The required filing fees are not enclosed but will be submitted in response to the Notice to File Missing Parts of Application.

[ ] The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741.

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Respectfully submitted,

Date 5 October 2000

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USE OF SOLUBLE COSTIMULATORY FACTOR FOR TUMOR IMMUNO-GENE THERAPY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a gene therapy for neoplasm, wherein a tumor cell is trasnduced with a gene encoding a soluble costimulatory factor. The transduced tumor cell secretes the costimulatory factor which induces T-cells to attack both transduced and untransduced cells of the tumor.

2. Description of the Related Art

The induction of an antigen-specific immune response requires three distinct interactions between antigen presenting cells (APCs) and antigen. The first interaction is adhesion, where APCs and T-cells randomly interact by adhesion molecules, which are cell surface ligands and their respective receptors. The second interaction, recognition, will occur if the APCs can process, transport, and present sufficient quantities of the antigen within a major histocompatibility complex (MHC) molecule. The antigen-MHC is then recognized by the T-cell via the ligation (*i.e.*, binding and cross-linking) of the T-cell receptor complex (TCR) to the antigen-MHC. The third interaction, costimulation, is needed for T-cells to induce cellular proliferation, cytokine secretion, and effector function. The second and third interactions are respectively known as signal 1 and signal 2. If signal 2 is not delivered, T-cells enter anergy, a state of long-term unresponsiveness to specific antigens.

Induction of tumor-specific cytotoxic T lymphocytes (CTL) requires the two signals noted above to be present on APCs. The first signal is a tumor antigen, which is processed, transported to, and presented by MHC class I and/or class II molecules on the surface of APCs. The second signal is a costimulatory molecule present on tumor cells and/or other APCs (Mueller et al., 1989, Annu. Rev. Immunol. 7:445-480). Anergy or tolerance to tumor cells occurs as a result of $CD8^+$ T-cells receiving the signal of a MHC-

bound tumor antigen, but not a second signal of costimulatory molecules (Schwartz, 1993, Sci. Am. 269:48-54).

Membrane proteins of the B7 family are known to be the most potent of the costimulatory molecules (Galea-Lauri et al., 1996, Cancer Gene Ther. 3:202-213). However, the expression of a single costimulatory factor on the tumor cell membrane is ineffective in nonimmunogenic tumors, presumably due to the lack of coexpression of MHC-bound tumor antigen (Chen et al., 1994, J. Exp. Med. 179:523-532).

The environment where an immune response is initiated can influence which types of cells become antigen presenting cells. In the peripheral blood, for example, dendritic cell, activated B cells, and monocytes serve as antigen presenting cells, whereas in the skin, keratinocytes and Langerhans cells present antigens. "Professional" APCs are cells such as dendritic cells, activated B cells, and activated macrophages, which can process and present antigens on their surface. Professional APCs have been found to have the ability to present tumor antigens in association with an MHC molecule. Tumor cells also can serve as APCs.

Huang et al. (1994, Science, 264:961-965) have found that MHC class I-restricted tumor antigens usually are not presented by the tumor itself, but by dendritic cells or bone-marrow-derived APCs. Dendritic cells are capable of efficiently presenting antigen derived from apoptotic cells or virus-infected cells, stimulating class I-restricted $CD8^+$ CTLs (Albert et al., 1998, Nature, 392:86-89). Dendritic cells that infiltrate tumors, however, can lack B7 molecules and therefore have reduced T-cell stimulatory activity (Chaux et al., 1996, Lab. Invest., 74:975-983).

Current gene therapies aimed at the control of cancer often fail because none of the current gene vectors are capable of infecting 100% of the cells of a tumor. Consequently, these therapies do not result in total destruction of the tumor.

SUMMARY OF THE INVENTION

The present invention addresses the problem of incomplete tumor antigen immunization by providing a gene therapy that entails delivering, to tumor cells, an expressible nucleotide sequence encoding a soluble costimulatory factor, thereby activating or enhancing the response of T-cells to a tumor. An "expressible nucleotide sequence" is a naturally occurring or man-made nucleotide sequence required for the production of a functional polypeptide.

When the soluble costimulatory factor is expressed within the tumor or the immediate area of the tumor, anergy is overcome, T-cell activation is stimulated, and activated T-cells infiltrating or surrounding the tumor mount an immune response to the tumor cells. Thus, the secreted costimulatory factor induces destruction of tumor cells regardless of whether they have or have not been transformed with the expressible nucleotide sequence.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic representation of an amplicon plasmid containing a B7-1-Ig gene.

Figure 2 is a graphic representation of the effect of dvB7-GPT on subcutaneous Neuro2a tumor growth in A/J mice.

Figure 3 is a graphic representation of the effect of dvB7-GPT on the survival of A/J mice with intracerebral Neuro2a tumors.

Figure 4 is a graphic representation of the lack of effect of dvB7-GPT on subcutaneous Neuro2a tumor growth in nude mice.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

By the use of soluble costimulatory factors, preferably of the B7 family, such as B7-1, the present invention overcomes the problem of T-cell anergy towards poorly immunogenic or nonimmunnogenic tumors. It is desirable to use soluble costimulatory factors such as B7-1 due to the limited ability of tumor cells to function effectively as APCs.

The present invention, by enabling the expression of a soluble costimulatory factor in the tumor environment, allows for T-cells to be activated in at least two ways. First, the presence of the soluble costimulatory factor provides dendritic cells and other APCs surrounding or infiltrating the tumor increased T-cell stimulation. Second, the presence of soluble costimulatory factors in the tumor environment can assist tumor cells in functioning as APCs because most types of tumor cells do not express B7 molecules (Chen et al., 1994, J. Exp. Med., 179: 523-532; Denfeld et al., 1995, Int. J. Cancer, 62:259-265). The first method of activation alone may suffice in inducing an immune response. Therefore, the second method of activation, antigen presentation by tumor cells

themselves, may not be necessary. In addition, the presence of costimulatory factors may reverse the anergic state of primed T-cells to an activated state.

In a preferred embodiment, the soluble costimulator is designed so that two extracellular domains are linked together. It has been shown that cross-linking of neighboring CD28, a counterreceptor on T-cells for the B7 molecule, is essential for T-cell activation (Schwartz et al., 1993, Sci Am, 269:48-54). Hence, a dimeric soluble costimulatory factor should advantageously provide stronger stimulation to T-cells than monomeric factor normally expressed on the cell surface. A preferred linker for the extracellular domains is the Fc portion of immunoglobulin (Ig)G. A particularly preferred embodiment of the soluble costimulatory factor is B7-1-IgG.

The invention is further described by reference to the examples below, with are set forth by illustration only. Nothing therein should be taken as a limitation upon the overall scope of the invention.

EXAMPLE 1

Herpes Simplex Virus Vector Construction

Defective herpes simplex virus (HSV) vectors containing a soluble B7-1 gene were used to demonstate the effectiveness of soluble costimulatory factor in tumor immuno-gene therapy. The soluble B7-1 (B7-1-Ig) was designed as a fusion protein of the extracellular domain of murine B7-1 and the Fc portion of human IgG1. To generate defective HSV vectors, an amplicon plasmid containing the B7-1-Ig gene was designed and constructed (Fig. 1).

The B7-1-Ig gene was initially cut out from the plasmid B7.1-pIg. The gene was inserted into another plasmid (pCR3) so that it is driven by the cytomegalovirus (CMV) immediate early promoter. The entire cassette, including the B7-1-Ig gene, was then cut out to construct the amplicon. The amplicon also contains the *Escherichia coli gpt* gene encoding the enzyme xanthine/guanine phosphoribosyltransferase and is driven by the SV40 promoter.

The *gpt* gene is used to select for a defective HSV. In the presence of mycophenolic acid with xanthine and hypoxanthine, the replication of helper HSV is blocked, whereas the defective HSV expressing the *gpt* gene shows a resistance to mycophenolic acid. This results in a defective HSV yield with a high defective to helper ratio. This is a novel approach to the generation of defective HSV vectors that is derived

from studies on vaccinia virus vectors (Falkner et al., 1988, J. Virol., 62:1849-1854; Falkner et al., 1990, J. Virol. 64:3108-3111). An added benefit of this vector is that *gpt* is able to convert the non-toxic substrate 6-thioxanthine (6-TX) into the toxic metabolite 6-TX-triphosphate (Mroz et al., 1993, Hum. Gene Ther. 4:589-595).

The defective HSV vector was generated using multimutated, conditionally-replicating HSV vector G207 as a helper virus and the mycophenolic acid/xanthine/hypoxanthine growth regimen. The defective HSV vector (dvB7-GPT) stock used in the studies had a defective to helper ratio of about 1:40, based on immunohistochemical detection of murine B7-1. A defective HSV vector containing the alkaline phosphatase gene instead of B7-1-Ig gene (dvAP-GPt) was also generated as a control.

EXAMPLE 2

In Vitro Expression of a Soluble Costimulatory Factor

Expression of B7-1-Ig in cultured cells infected by dvB7-GPT was detected by several methods. When Vero (African green monkey kidney) cells and Neuro2a (murine neuroblastoma) cells were infected with dvB7-GPT at a multiplicity of infection (MOI) of 0.25 and 3 (helper titer), respectively, immunohistochemical expression of B7-1-Ig was detected by antibodies against murine B7-1 and human IgG (Fc). When assessed by enzyme-linked immunosorbent assay (ELISA) for human IgG, conditioned medium collected from dvB7-GPT-infected Neuro2a cells (MOI=3) 68 hours post-infection was found to contain 0.34 ng/ml of secreted B7-1-Ig.

EXAMPLE 3

In Vivo Effects of a Soluble Costimulatory Factor

An immunocompetent tumor model of A/J mice and syngeneic Neuro2a cells was used for *in vivo* studies. When A/J mice harboring established subcutaneous (s.c.) Neuro2a tumors (approximately 6 mm in diameter) were treated with two intratumoral inoculations of dvB7-GPT (2×10^5 plaque forming units (pfu) of helper virus). Inoculations were performed three days apart. A significant inhibition of tumor growth was observed compared with mock-infected extract (mock) or dvAP-GPT of the same dose ($p < 0.01$ versus mock and $p < 0.05$ versus dvAP-GPT at day 17, unpaired *t* test; Fig. 2). A/J mice were injected intracerebrally with Neuro2a cells and treated five days later with a stereotactic inoculation of dvB7-GPT (6×10^5 pfu of helper virus) at the same coordinates.

A significant prolongation of median survival was observed compared with mock or dvAP-GPT ($p < 0.001$ versus mock and $p < 0.05$ versus dvAP-GPT, Wilcoxon test; Fig. 3).

Expression of B7-1-Ig *in vivo* was detected subcutaneously. Neuro2a tumors were harvested 2 days after dvB7-GPT inoculation and immunostained for human IgG (Fc). When the same tumors were immunostained for CD4, CD8 and Mac-3, abundant $CD4^+$ T-cells and fewer $CD8^+$ T-cells were observed in areas corresponding to dvB7-GPT infection, but were not observed in dvAP-GPT-inoculated s.c. tumors. Mac-3-positive macrophages were observed ubiquitously in both dvB7-GPT- and dvAP-GPT-inoculated tumors.

When athymic nude mice (Balb/c nu/nu) harboring established s.c. Neuro2a tumors (approximately 6 mm in diameter) were treated with intratumoral inoculation of dvB7-GPT in exactly the same manner and dosage as were A/J mice, no significant effect on tumor growth was observed compared with mock or dvAP-GPT (Fig. 4). Thus, B7-1-Ig gene delivery into tumor results in efficient antitumor activity in immunocompetent animals, and the data support that the effect is mediated by a T-cell response.

Survivors from the subcutaneous Neuro2a rechallenge study were further challenged with a subcutaneous injection of SaI/N, A/J-derived sarcoma cells (5×10^6). All mice cured by B7-1-Ig, as well as all 6 naïve A/J mice used as controls, showed tumor formation at 4 weeks post-implantation. This finding indicates that the protective antitumor immunity was specific to Neuro 2a cells.

Localized delivery of vectors expressing soluble costimulatory factor are superior to systemic delivery of soluble costimulatory factor due to the following reasons: (1) Local secretion offers an abundant amount of costimulatory factor to APCs that have processed tumor antigens in the tumor-surrounding environment, causing increased T-cell stimulatory activity with a specific direction to the tumor cells. (2) Soluble costimulatory factor secreted from tumor cells should activate local T-cells by reversing the anergic state. (3) Local vector administration causes soluble B7-1 to be expressed almost exclusively by tumor cells, therefore allowing tumors cells, but not other non-professional APCs, to function as APCs. (4) Local vector administration can provide higher concentration and more localized distribution of soluble costimulatory in the tumor and the surrounding region than systemic administration. (5) Systemic administration of soluble costimulatory factor may cause activation of T-cells primed to various types of antigens. Such a non-specific immune response may trigger immune responses against irrelevant antigens, or

normal tissues or organs, potentially causing an undesirable toxicity or an autoimmune disease. Vector-mediated local administration of IL-12 has been shown to cause minimal side effects, whereas systemic administration of IL-12 has been found to be relatively toxic in humans.

This invention also can be applied to tumor vaccination using *ex vivo* methods. Tumor cells surgically obtained from a patient can be grown in culture, transduced with soluble costimulatory molecule gene, and injected subcutaneously into the same patient for tumor vaccination.

The concept of using a soluble costimulatory factor is not limited to B7-1. Rather, other costimulatory factors that are normally expressed on the cell surface of APCs, such as B7-2, CD40, CD72, CD2, can be used. Other costimulatory factors which may be used include B7-3, CD40 ligand, CD70, CD24, LFA-3, CD48, 4-1BB, 4-1BB ligand, LIGHT, ICAM-1 (CD54).

Additionally, different costimulatory pathways work synergistically. Therefore, a combination of two or more different types of costimulatory molecules listed above (soluble or not) is more potent in stimulating the immune response than each costimulatory factor alone, for example, B7-1 and CD48 (Li et al., 1996, J. Exp. Med., 183:639-44). Furthermore, it has been demonstrated *in vivo* that IL-12 (Rao et al., 1996, J. Immunol., 156:3357-3365; Zitvogel et al., 1996, Eur. Immunol., 26:1335-1341), interferon gamma (Katsanis et al., 1996, Cancer Gene Ther. 3:75-82), GM-CSF (Parney et al., 1997, Hum. Gene Ther., 8: 1073-1085), ICAM-1 (Cavallo et al., 1995, Eur. J. Immunol., 25:1154-1162), or MHC class II (Baskar et al., 1996, J. Immunol. 156:3821-3827; Heuer et al., 1996, Hum. Gene Ther. 7:2059-2068) expressed together with B7 molecules enhances the stimulation of antitumor immunity.

Moreover, the fusion does not have to involve IgG. Rather, any protein or peptide sequence that will allow two B7-1 molecules to cross-link their cognate receptors can be used. Vectors other than the HSV vector described above can be used. These include viral vectors such as herpes simplex virus, retrovirus, adenovirus, adeno-associated virus, vaccinia virus, avipox virus, baculovirus, and reovirus, and others.

Furthermore, other HSV vectors which can be employed include replication-competent HSV, replication-incompetent HSV, and HSV amplicon vectors with or without helper virus. Non-viral vectors as well as viral vectors can potentially be used. The

immuno-gene therapy of the present invention can be applied to any type of solid tumor. Delivery can be by direct intratumoral inoculation or systemic delivery.

The neuroblastoma model described herein is predictive of efficacy with other tumor types. It has been previously shown that defective HSV vectors (HSV amplicon vectors with helper HSV) expressing HSV-thymidine kinase or IL-12 can exhibit antitumor effects as effectively as other vectors (retrovirus, adenovirus) with the same transgenes (Miyatake et al., 1997, Cancer Gene Ther. 4:222-228; Toda et al., 1998, J. Immunol. 160:4457-4464). The animal tumor model used to show the effect of soluble B7-1 was chosen because Neuro2a cells form intracerebral tumors as well as subcutaneous tumors reproducibly in A/J mice with a 100% take rate, the tumors are fast-growing, and the model has been used to study the effect of cell surface B7 molecules.

It has been shown that Neuro2a cells transduced with B7-1 alone, even with 100% of cells expressing B7-1, fails to induce significant immunological protection (Heuer et al., 1996, Hum. Gene Ther. 7:2059-2068; Katsanis et al., 1995, Cancer Gene Ther. 2:39-46), which is in agreement with other poorly immunogenic tumors (Li et al., 1996, J. Exp. Med., 183:639-44; Chen et al., 1994, J. Exp. Med. 179:523-532). Neuro2a is known as one of the most poorly immunogenic cell lines, and therefore, can be considered as one of the most difficult targets for immunogene therapy. Since the present invention is effective with the relatively non-immunogenic Neuro2a cells, one understands that it will be effective with more immunogenic tumors.

WE CLAIM:

1. A gene-therapy method of activating or enhancing a T-cell response in a patient with a tumor, comprising administering to said patient a pharmaceutical composition comprising: (A) an expressible nucleotide sequence for a soluble costimulatory factor and (B) a vector, such that (i) said factor is expressed by the tumor cells or the tumor-related cells, and (ii) said T-cell response thereby is activated or enhanced against said tumor.

2. The method according to claim 1, wherein said vector is targeted to tumor cells or tumor-related cells.

3. The method according to claim 2, wherein said vector is a viral vector.

4. The method according to claim 3, wherein said viral vector is selected from the group consisting of viral families, retroviridae, reoviridae, adenoviridae, parvoviridae, herpesviridae, poxviridae, hepatitis delta virus, and baculovirus.

5. The method according to claim 2, wherein said vector is a non-viral vector.

6. The method according to claim 5, wherein said non-viral vector is a molecular conjugate vector or a synthetic virus.

7. The method according to claim 1, wherein said administrating comprises introducing said composition directly into said tumor or a local area of said tumor.

8. The method according to claim 7, wherein said administering comprises directly injecting said nucleotide sequence, or directly injecting said nucleotide sequence conjugated to a liposome carrier.

9. The method according to claim 7, wherein said vector is a viral vector.

10. The method according to claim 8, wherein said viral vector is selected from the group consisting of viral families, retroviridae, reoviridae, adenoviridae, parvoviridae, herpesviridae, poxviridae, hepatitis delta virus, and baculovirus.

11. The method according to claim 7, wherein said vector is a non-viral vector.

12. The method according to claim 1, wherein said factor is selected from the group consisting of B7-1, B7-2, B7-3, CD40, CD40 ligand, CD72, CD24, LFA-3, ICAM-1, CD70, CD2, CD48, 4-1BB, 4-1BB ligand, and LIGHT.

13. The method according to claim 12, wherein said factor comprises two extracellular domains.

14. The method according to claim 1, wherein said factor comprises an immunoglobulin Fc region.

15. The method of claim 1, wherein said factor comprises a dimer.

16. The method of claim 15, wherein the monomers of said dimer are connected by a linker.

17. The method of claim 1, wherein said vector is a viral vector.

18. The method of claim 1, wherein said vector is a non-viral vector.

19. The method of claim 1, wherein said tumor is selected from the group consisting of astrocytoma, oligodendroglioma, meningioma, neurofibroma, glioblastoma, ependymoma, Schwannoma, neurofibrosarcoma, medulloblastoma, germ cell tumor, chordoma, pineal tumor, choroid plexus papilloma, pituitary tumor, and vascular tumor.

20. The method of claim 1, wherein said tumor cells or tumor-related cells are selected from the group consisting of melanoma cells, pancreatic cancer cells, prostate carcinoma cells, head and neck cancer cells, breast cancer cells, lung cancer cells, colon cancer cells, ovarian cancer cells, renal cancer cells, neuroblastomas, squamous cell carcinomas, hepatoma cells, and mesothelioma and epidermoid carcinoma cells.

21. The method of claim 1, wherein said administering further comprises delivering to said patient at least one expressible nucleotide sequence coding for an immune modulator.

22. The method of claim 21, wherein said immune modulator is selected from the group consisting of a cytokine, a chemokine, and a membrane-bound costimulatory molecule.

23. A pharmaceutical composition comprising (A) a vector that contains gene encoding a soluble costimulatory factor and (B) a pharmaceutically compatible carrier.

24. A gene-therapy method of activating or enhancing a T-cell response in a patient with a tumor, comprising administering to said patient a pharmaceutical composition comprising: an expressible nucleotide sequence for a soluble costimulatory factor such that (i) said factor is expressed by the tumor cells or the tumor-related cells, and (ii) said T-cell response thereby is activated or enhanced against said tumor.

25. The method according to claim 24, wherein said administrating comprises introducing said composition directly into said tumor or a local area of said tumor.

26. The method according to claim 24, wherein said factor is selected from the group consisting of B7-1, B7-2, B7-3, CD40, CD40 ligand, CD72, CD24, LFA-3, ICAM-1, CD70, CD2, CD48, 4-1BB, 4-1BB ligand, and LIGHT.

27. The method according to claim 26, wherein said factor comprises two extracellular domains.

28. The method of claim 24, wherein said tumor is selected from the group consisting of astrocytoma, oligodendroglioma, meningioma, neurofibroma, glioblastoma, ependymoma, Schwannoma, neurofibrosarcoma, medulloblastoma, germ cell tumor, chordoma, pineal tumor, choroid plexus papilloma, pituitary tumor, and vascular tumor.

29. The method of claim 24, wherein said tumor cells or tumor-related cells are selected from the group consisting of melanoma cells, pancreatic cancer cells, prostate carcinoma cells, head and neck cancer cells, breast cancer cells, lung cancer cells, colon cancer cells, ovarian cancer cells, renal cancer cells, neuroblastomas, squamous cell carcinomas, hepatoma cells and mesothelioma and epidermoid carcinoma cells.

30. The method of claim 24, wherein said administering comprises delivering to said patient at least one expressible nucleotide sequence coding for at least one immune modulator.

31. The method of claim 30, wherein said immune modulator is selected from the group consisting of cytokines, chemokines, and membrane-bound costimulatory molecules.

32. A pharmaceutical composition comprising (A) a gene encoding a soluble costimulatory factor and (B) a pharmaceutically compatible carrier.

ABSTRACT OF THE DISCLOSURE

A new gene therapy entails tumor treatment by introducing an expressible nucleotide sequence for a soluble costimulatory factor, thereby enhancing the response of T-cells to a tumor. *In vivo* expression of the soluble factor overcomes anergy or tolerance to tumor cells and activates T-cells that are infiltrating or surrounding the tumor. A pharmaceutical composition containing such a gene is effective in tumor suppression.

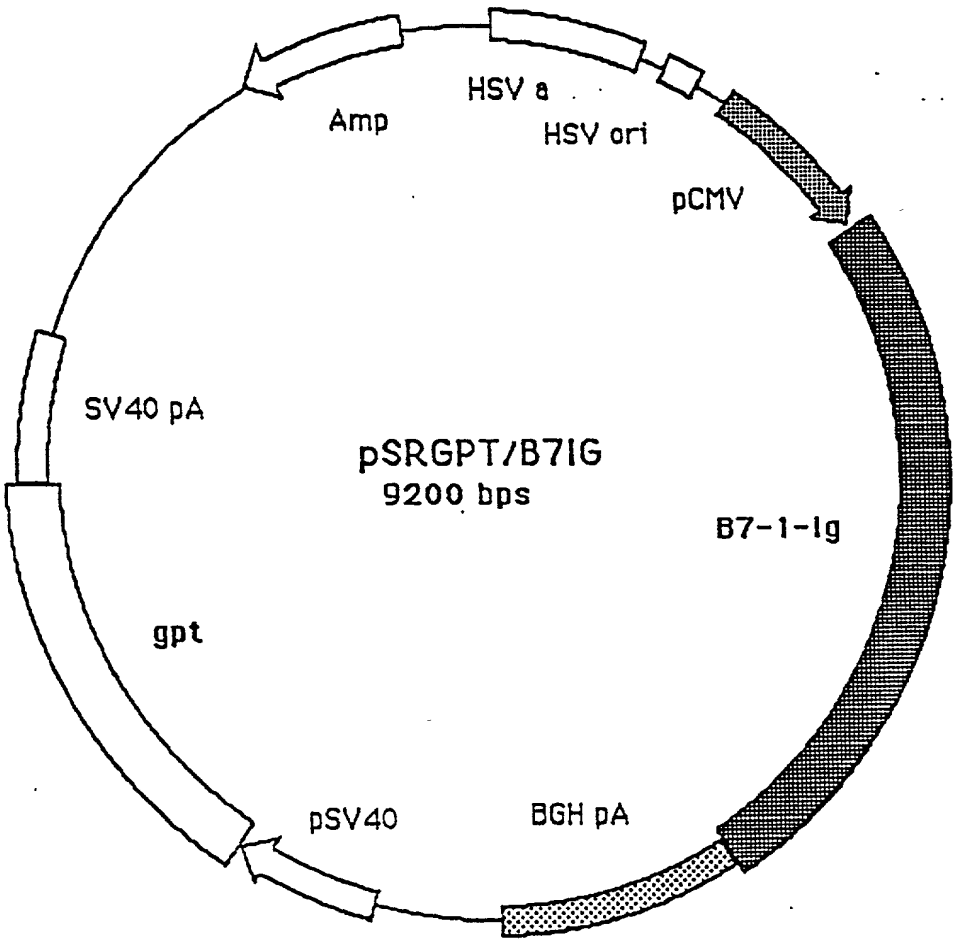

Figure 1. Construct of amplicon plasmid containing B7-1-Ig gene.

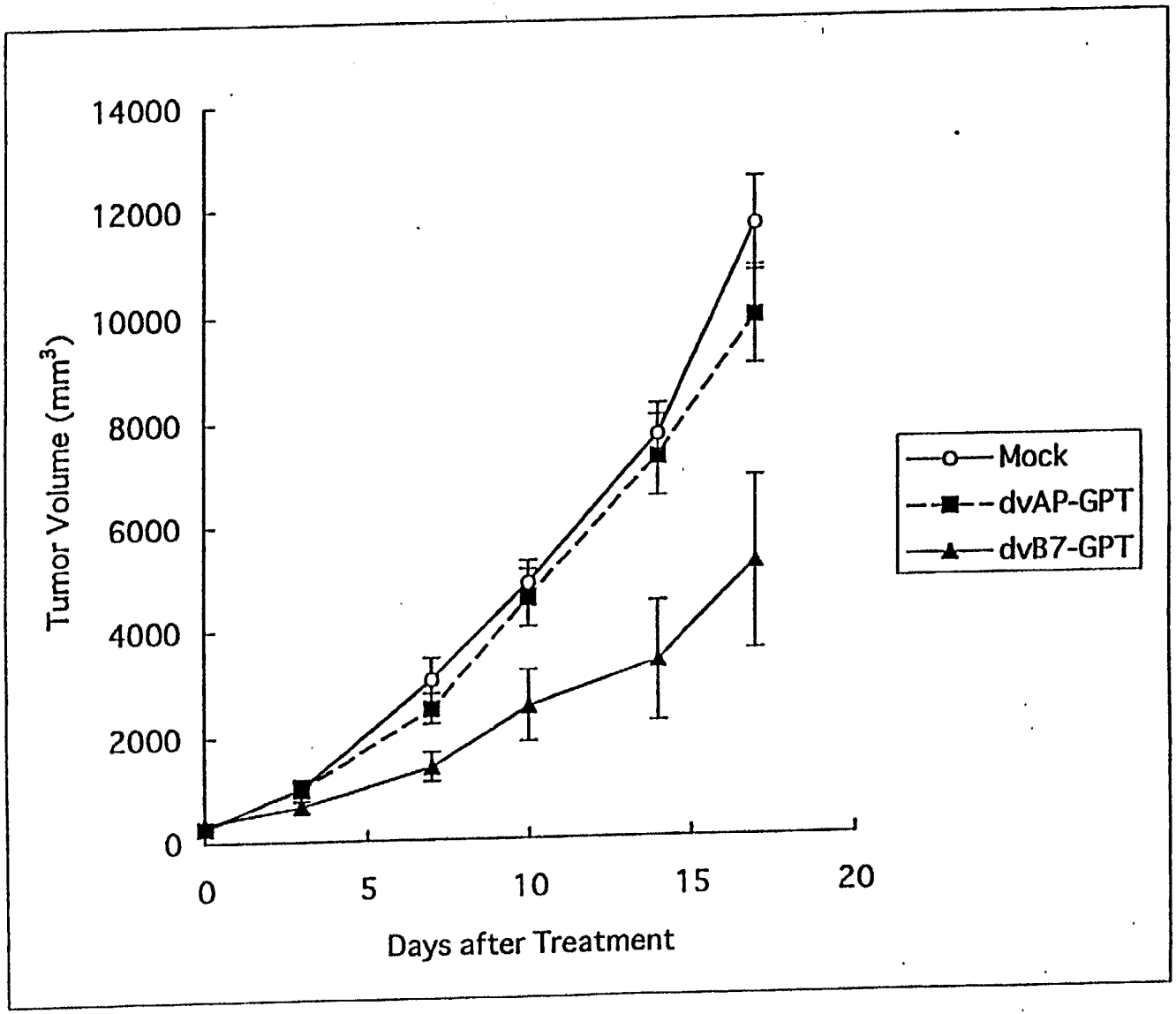

Figure 2. Effect of dvB7-GPT on subcutaneous Neuro2a tumor growth in A/J mice.

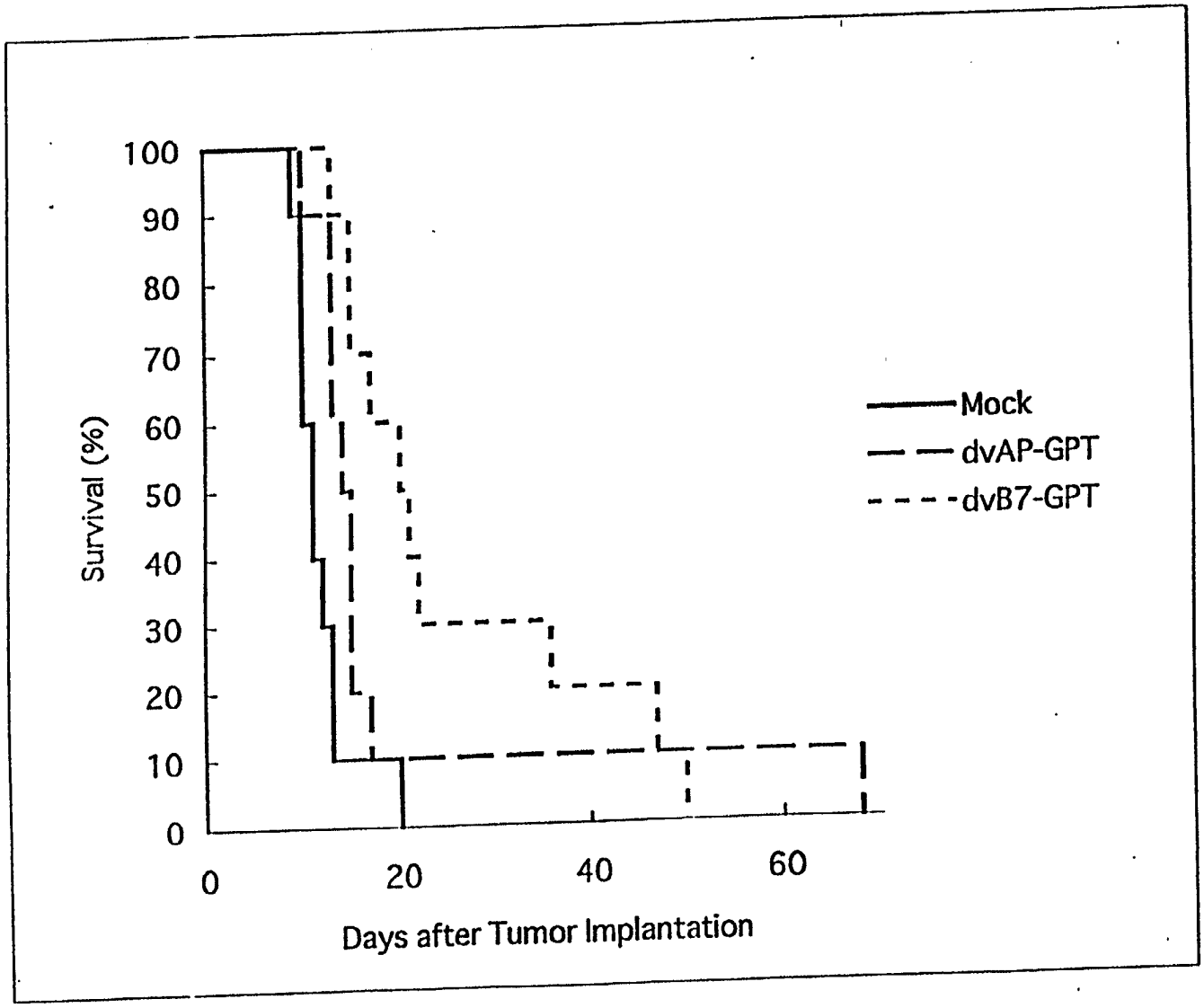

Figure 3. Effect of dvB7-GPT on survival of A/J mice with intracerebral Neuro2a tumors.

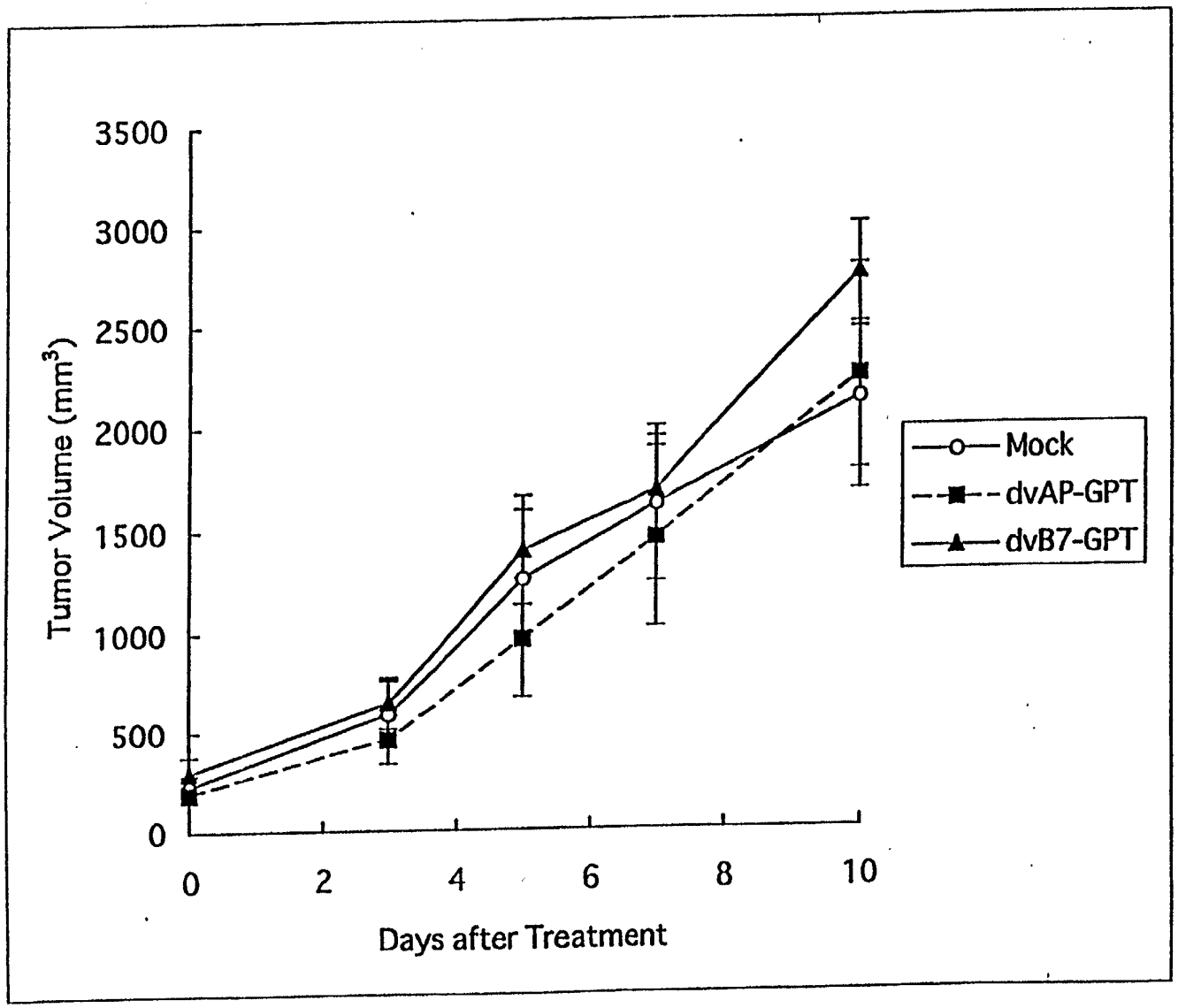

Figure 4. Lack of effect of dvB7-GPT on subcutaneous Neuro2a tumor growth in nude mice.

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

USE OF SOLUBLE COSTIMULATORY FACTOR FOR TUMOR IMMUNO-GENE THERAPY

(Attorney Docket No. 066683/0188)

the specification of which (check one)

____ is attached hereto.

__X__ was filed on __October 5, 2000__ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

THAT I do not know and do not believe that the same invention was patented or described in any printed publication in any country, or in public use or on sale in the United States of America, for more than one year prior to the filing date of this United States application;

THAT I do not know and do not believe that the same invention was first patented or made the subject of an inventor's certificate that issued in any country foreign to the United States of America before the filing date of this United States application if the foreign application was filed by me (us), or by my (our) legal representatives or assigns, more than twelve months (six months for design patents) prior to the filing date of this United States application;

THAT I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment specifically referred to above;

THAT I believe that the above-identified specification contains a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention, and sets forth the best mode contemplated by me of carrying out the invention; and

THAT I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I HEREBY CLAIM foreign priority benefits under Title 35, United States Code §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date
60/157,787	October 5, 1999

I HEREBY CLAIM the benefit under Title 35, United States Code, §120 of any United States application(s), or § 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

I HEREBY APPOINT the following registered attorneys and agents of the law firm of FOLEY & LARDNER to have full power to prosecute this application and any continuations, divisions, reissues, and reexaminations thereof, to receive the patent, and to transact all business in the United States Patent and Trademark Office connected therewith:

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I UNDERSTAND AND AGREE THAT the foregoing attorneys and agents appointed by me to prosecute this application do not personally represent me or my legal interests, but instead represent the interests of the legal owner(s) of the invention described in this application.

I FURTHER DECLARE THAT all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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